

Impatiens chenmoui (Balsaminaceae), a new species from southern Yunnan, China

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Abstract

Impatiens chenmoui (Balsaminaceae), a new species from southern Yunnan, China, was described and illustrated based on morphological and molecular evidence. This new species is morphologically most similar to *Impatiens oblongata* Ruchis. & Niet, but can be distinguished by 7–9 pairs of leaf veins, glabrous perianth, obovate upper petal, and capsule with trichome.

Keywords

China, *Impatiens chenmoui*, morphology, phylogeny, sect. *Uniflorae*

Introduction

The family Balsaminaceae contains two genera, the monotypic *Hydrocera* Blume (1825:241) and *Impatiens* Linnaeus (1753: 937) (APG Website, <http://www.mobot.org/MOBOT/research/APweb/>) *Impatiens* L. is a large genus of over 1000 species (Grey-Wilson 1980; Fischer 2004), mainly distributed in tropical and subtropical regions, with tropical Africa, Madagascar, southern India and Sri Lanka, eastern Himalayas (including SW China) and Southeast Asia as its five diversity centers (Song et al. 2003; Yuan et al. 2004; Yu et al. 2015). More than 270 species are currently known from China (Yu 2012), in which more than 200 species occurred in SW China (Chen et al. 2007), mainly distributed in Yunnan, Sichuan, Guangxi, Guizhou, and Xizang. *Impatiens* was divided into two subgenera, subgen. *Clavicarpa* S.X. Yu ex S.X. Yu & Wei Wang and subgen. *Impatiens* L. according to the latest phylogenetic studies. The

latter was further subdivided into seven sections (sect. *Fasciculatae*, sect. *Impatiens*, sect. *Racemosae*, sect. *Scorpioidae*, sect. *Semeiocardium*, sect. *Tuberosae*, and sect. *Uniflorae*) (Yu et al. 2015). Several new species of sect. *Uniflorae* have been described from India, Myanmar, Cambodia, Vietnam, and China. (e.g. Cho et al. 2017; Yang et al. 2017; Ruchisansakun et al. 2018; Kim et al. 2019; Zhang et al. 2020) in recent years.

In September 2019, during fieldwork in Mengla County, Yunnan, an unfamiliar *Impatiens* species was collected and transplanted to Shanghai Chenshan Botanical Garden. The flower blossomed in December 2020, indicating its unusual identity which may be new to science. In November 2021, we made a botanical trip back to Mengla County to collect flowers and fruit specimens. After careful comparison of relevant species from the adjacent area, we finally concluded that these specimens represent a species new to science, and described it here.

Methods

Morphology study

Morphological characters of the new species and related ones were compared based on living plants and herbarium specimens, including the digital resource of type specimens from JSTOR Global Plants (<https://plants.jstor.org/>). Herbarium specimens were examined in Chenshan Botanical Herbarium (CSH, index herbarium, <http://sweetgum.nybg.org/science/ih/herbarium-list/?NamOrganisationAcronym=CSH>), original protologues and relevant literature were also investigated.

Datasets preparation

To resolve the phylogenetic position of the putative new species, two molecular markers ITS (ITS1–5.8S–ITS2) and *atpB-rbcL* were used in this study. Leaf material of the putative new species was collected from the field and stored with silica. Total genomic DNA was extracted with the modified CTAB method (Doyle and Doyle 1987) for library construction at Benagen (<https://www.benagen.com>). Paired-end sequencing of the whole sequences from both ends of 150 bp fragments was performed on the DNBSEQ T7, and about 2 Gb clean data were produced. The plastome and nrDNA were de novo assembled using the GetOrganelle pipeline 1.7.6.1 (Jin et al. 2020). Sequences of *atpB-rbcL* were extracted from the plastome annotated in Geneious Prime 2021.2.2 (<https://www.geneious.com>) with comparison to the published plastome of *Impatiens balsamina* L. (GenBank accession: [MW411292](https://www.ncbi.nlm.nih.gov/nuccore/MW411292)) as reference. Sequences of ITS1–5.8s–ITS2 were extracted with ITSx 1.1.3 (Bengtsson-Palme et al. 2013). The ITS dataset and the *atpB-rbcL* dataset were respectively aligned using MAFFT v7.450 by default setting. (Katoh and Standley 2013) and concatenated for phylogenetic analysis (Chen et al. 2020). Species sampling was based on previous studies (Yu et al. 2015; Ruchisansakun et al. 2018). All the sequence GenBank accession numbers were listed in Appendix 1.

Phylogenetic analysis

Maximum Likelihood estimation (ML) and Bayesian inference analysis (BI) were performed on Phylosuite v1.2.2 (Zhang et al. 2020). For ML, GTR+F+R4 was selected as the best fit model for the ITS dataset, and GTR+F+R5 was selected as the best fit model for the *atpB-rbcL* dataset according to AICc by Modelfinder (Kalyaanamoorthy et al. 2017). Maximum likelihood was estimated using IQ-TREE (Nguyen et al. 2015) under the Edge-linked partition model for 2000 ultrafast (Minh et al. 2013) bootstraps. For BI, GTR+I+G was selected as the best fit model for both datasets according to AICc by PartitionFinder2 (Lanfear et al. 2017). Bayesian Inference phylogeny analysis was inferred using MrBayes 3.2.6 (Ronquist et al. 2012) under the partition model (2 parallel runs, 10,000,000 generations), in which the initial 25000 sampled data were discarded as burn-in. Tree files were visualized and annotated in Figtree v1.4.4 (<http://tree.bio.ed.ac.uk/software/figtree/>). Bootstrap (BS) and Posterior Probability (PP) values were used as an estimate of nodal robustness.

Result

The combined dataset was 1934bp in total, comprising 107 accessions/107 species, with *Hydrocera triflora* (L.) Wight. et Arn. selected as outgroup. Phylogenetic reconstruction of BI and ML produced similar topological structures (Fig. 1). The putative new species (marked in red) was resolved in the subgen. *Impatiens* sect. *Uniflorae*, forming a sister relationship with Myanmar species *I. oblongata* Ruchis. & Niet (PP = 0.957, BS = 94). Based on the morphological characters and phylogenetic result, we recognized this *Impatiens* species as a new species and described it here as *Impatiens chenmoui* Zheng W. Wang, Xiao C. Li & Qi Wang, sp. nov.

Taxonomic treatment

***Impatiens chenmoui* Zheng W. Wang, Xiao C. Li & Q. Wang ter, sp. nov.**

urn:lsid:ipni.org:names:77309066-1

Figs 2, 3, Appendix 2

Type. CHINA. Yunnan province, Mengla county (勐腊县) Xiangming Yi nationality township (象明彝族自治乡) Kongming Mountain (孔明山) alt.1639m, 22°8'9.73"N, 101°8'48.86"E, 23 November 2021, *Zhengwei Wang and Xiaochen Li*, WZW04250 (Holotype: CSH0189505, CSH!; isotypes: CSH0192380, ZJFC!; CSH0189507, HZU!; CSH0189506, JJF!).

Diagnosis. *Impatiens chenmoui* is most similar to *I. oblongata* Ruchis. & Niet, but is distinguished by the glabrous dorsal petal, pedicel, and bracts, longer pedicel and spur, and fewer lateral sepals (Table 1).



Figure 1. Phylogenetic tree based on combined datasets of the nuclear ITS and plastid *atpB-rbcL* DNA sequences. The topological structure comes from Bayesian inference. Numbers near nodes are PP/BS, a dash ‘–’ indicates nodes not supported, subgen. *Clavicarpa* was collapsed.

Description. Herb annual. Stem erect, fleshy, glabrous, 12–35 cm tall. Leaves alternate, petioles 1–5 cm, leaf blade 9.5–2.5×1.6–3.5 cm, narrowly elliptic or oblong-lanceolate, apex acuminate or long acuminate, base cuneate, margin roughly crenate; adaxially dark green, pilose along veins, abaxially gray-green, glabrous, lateral veins 7–9 pairs. Inflorescences in upper leaf axils, 1-flowered. Pedicels green, glabrous, 2.5

–2.7 cm long. Bracts linear, persistent, 2–3 mm long. Flowers solitary, axillary, pink, or lavender, with pair of darker pink and yellow dots at the base. Lateral sepals 2, inversely coiled, glabrous, green, 2 mm long. Lower sepal funnelform, 3–4×2–3mm long, 2–3mm in depth, eaves navicular, base gradually constricted into a spur, variable, usually 1.4–1.7 cm long, rarely absent, mouth oblique, ca. 5mm wide, with ca. 2 mm long narrowly triangular tip. Dorsal petal circular, pink or mauve, 5–6×4–5mm, apex acuminate, glabrous, ca. 2mm long. United lateral petals sessile, 2-lobed, 6–8mm long. Upper petal large, obovate, 6–7×2–5mm, apex often concave. Lower petal small, axe-shaped, 7–8×1–3mm, apex rounded, without auriculus at back. Stamens 5, filaments linear, subulate, pale pink, ca. 2–3mm long, distally enlarged, anthers obtuse. Ovary fusiform, 5–carpellate, purple, 2–3 mm long, dorsal suture ridges with trichome. Capsule short fusiform, 12–18mm long, 4–5 mm in diam, with trichome along ridges. Seeds obovoid, brown, ca. 2 mm long, slightly compressed, pubescent with spirally sculptured hairs.

Phenology. Flowering and fruiting from October to December.

Distribution and ecology. This new species was found under evergreen broad-leaved forest at an elevation of 1500–1700 m on the limestone mountain ridge, and was currently known as only one population in Mengla County, Yunnan, China. This distribution area is very close to the border with Myanmar and Laos. We assume that this species should be also distributed in Myanmar and Laos due to their similar habitat.

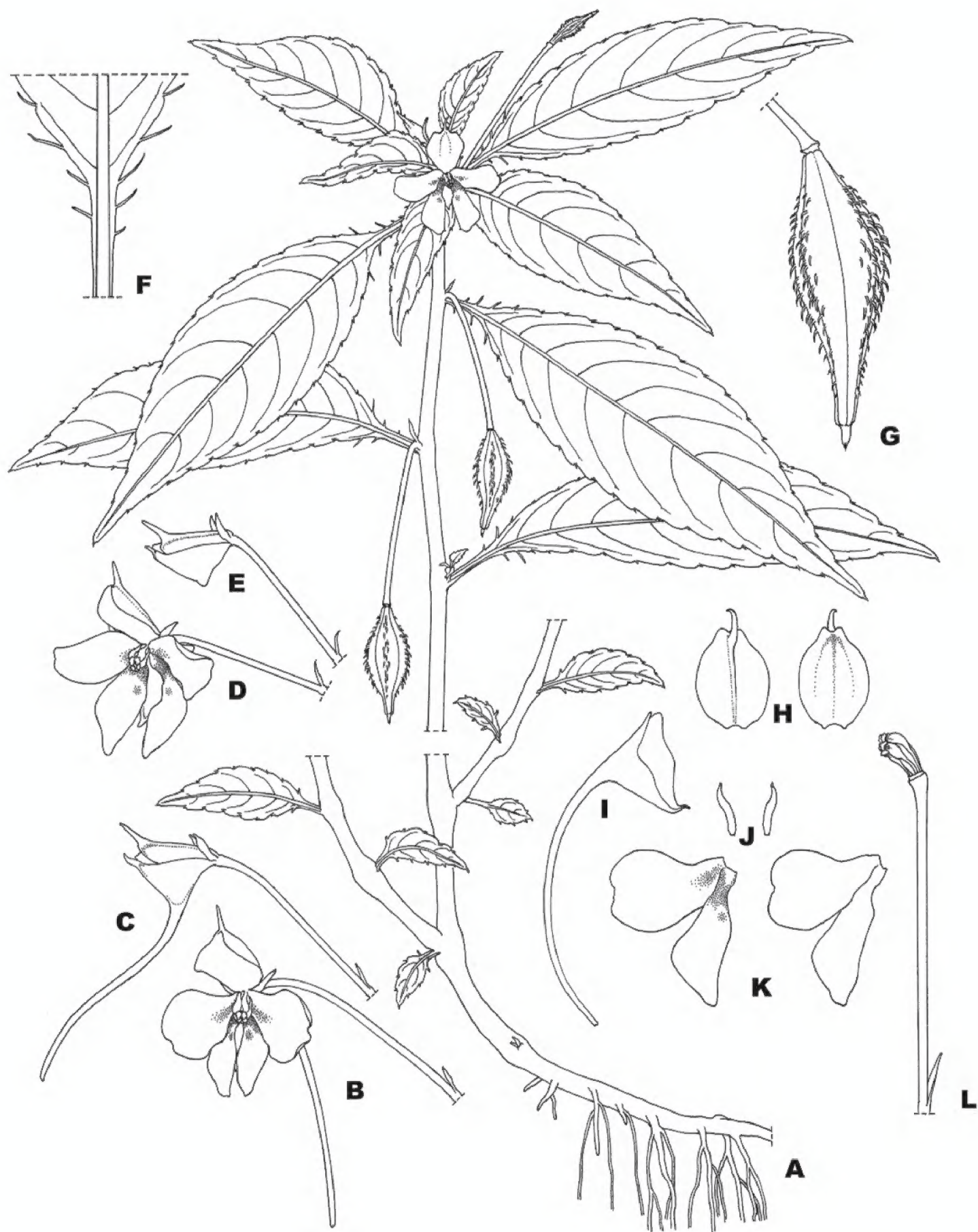
Etymology. The specific epithet “Chenmoui” was dedicated to the famous Chinese collector and botanist, Chen Mou (陈谋) (1903–1935) who was one of the founders of the first botanical garden cataloged by the Classification System of Plants in China, and died during the collection trip through southern Yunnan, China. The Chinese name was given as “陈谋凤仙花”.

Conservation status. This species is currently known only from one population in the type locality. The population is located in the tourist area of Kongming Mountain, where it could be easily disturbed by human activities, such as road construction and illegal mining. The IUCN status proposed is Vulnerable(VU) based on IUCN (2022) guidelines.

Additional specimens examined (Paratype). China, Yunnan province, Mengla county, Xiangming Yi nationality township, Kongming Mountain. 24 Oct. 2019, *Ruhua Xu and Yu Zhang*, XRH001(CSH!).

Table 1. Comparison of key features of *I. chenmoui* and *I. oblongata*.

Taxonomic traits	<i>I. chenmoui</i>	<i>I. oblongata</i>
Dorsal petal	Glabrous	midrib and tip pilose
Pedicel	25–27 mm long, green, glabrous.	18–20 mm long, pink, pilose.
Ovary hair	Trichome	Pilose
Spur	14–17 mm long, glabrous, rarely absent.	8–12 mm long, pilose.
Bracts	Glabrous	Pilose
Lateral sepals	2, inversely coiled, glabrous	2–4, upper pair pilose; lower pair glabrous



Tianyi Yu 2022.3.14

Figure 2. *Impatiens chenmouii* sp. nov. **A** habit **B, C** flower with long spur **D, E** flower with spur nearly absent **F** leaf base **G** capsule **H** dorsal petal **I** spur **J** lateral sepals **K** united lateral petals **L** ovary surrounded by stamens.

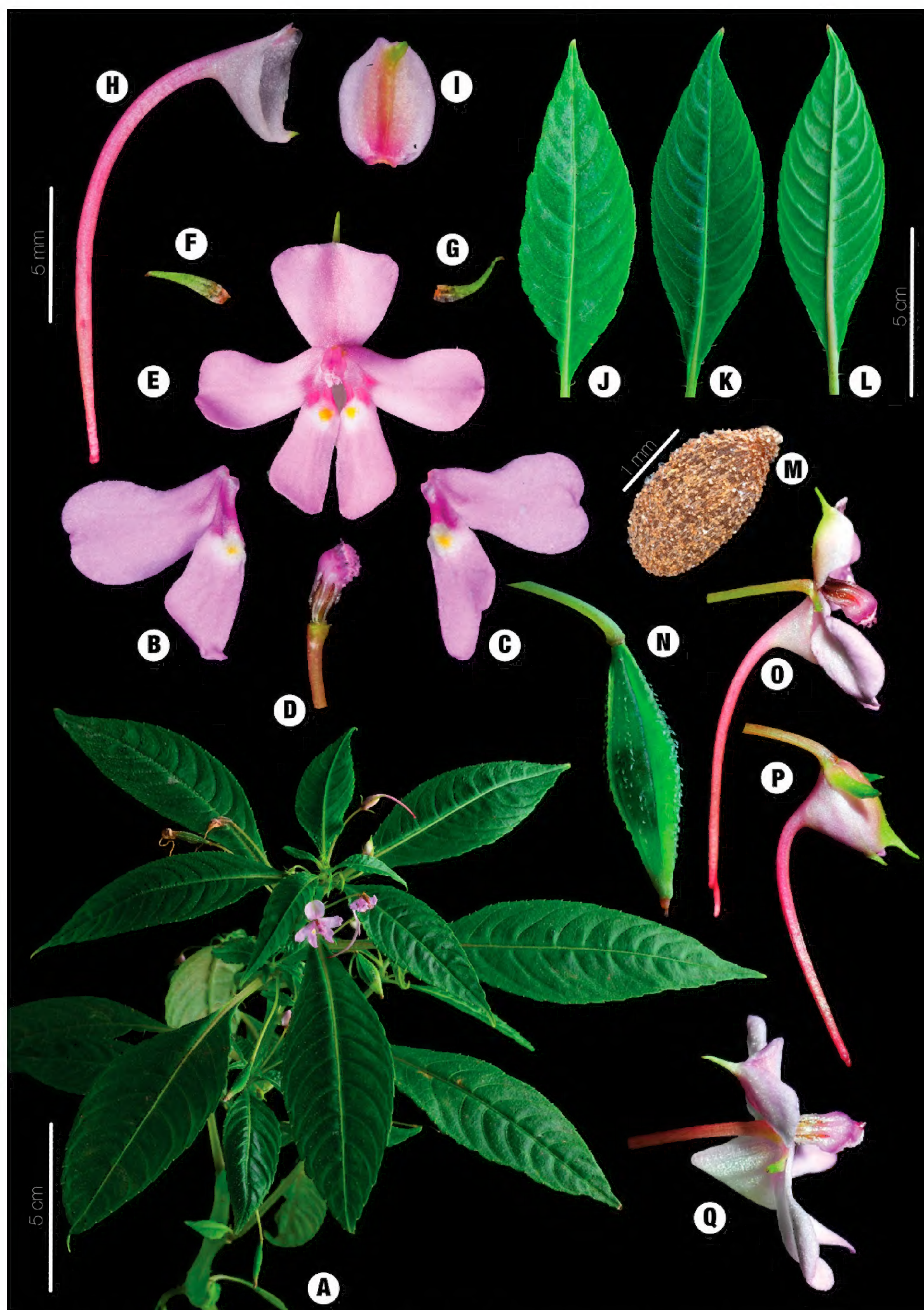


Figure 3. *Impatiens chenmouii* sp. nov. **A** habit **B, C** united lateral petals **D** ovary surrounded by stamens **E** flower front view **F, G** lateral sepals **H** spur **I** dorsal petal **J–L** leaves **M** seed **N** capsule **O, P** long-spurred flower side view **Q** non-spurred flower side view.

Note. New species of sect. *Uniflorae* discovered from Southeast Asia in recent years were mostly found distributed on mountain summits in an evergreen forest, which indicated that the stone mountain in this area was likely to be one of the speciation centers of this section. *Impatiens* species exhibited interspecific and even intraspecific variation in spur length, at least from our observation of the same population of *I. davidii* Franchet, *I. platysepala* Y. L. Chen, and *I. chenmoui*, which may be considered as retaining of a bimodal pollinated system of bee and lepidopteran (Ruchisansakun et al. 2016). Floristic survey and pollination ecology study in these regions' *Impatiens* species is still insufficient, and more fieldwork is urgently needed.

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Appendix I

Table A1. Species and sequences sampling list with Genbank accession number.

Species	ITS	<i>atpB-rbcL</i>
<i>Hydrocera triflora</i>	AY348853	DQ147895
<i>Impatiens apalophylla</i>	KP776061	KP776011
<i>Impatiens aquatilis</i>	AY348745	DQ147811
<i>Impatiens arguta</i>	AY348746	DQ147812
<i>Impatiens aureliana</i>	AY348747	DQ147814
<i>Impatiens balansae</i>	KP776062	KP776012
<i>Impatiens balsamina</i>	AY348749	DQ147816
<i>Impatiens begoniifolia</i>	AY348752	DQ147819
<i>Impatiens bicornuta</i>	AY348754	DQ147821
<i>Impatiens blinii</i>	KP776063	KP776013
<i>Impatiens campanulata</i>	AY348758	DQ147822
<i>Impatiens capensis</i>	AY348759	DQ147823
<i>Impatiens chekiangensis</i>	KP776064	KP776014
<i>Impatiens chenmoui</i>	OP035808	OP095354
<i>Impatiens chinensis</i>	AY348761	DQ147825
<i>Impatiens chishuiensis</i>	KP776065	KP776015
<i>Impatiens chiulungensis</i>	KP776066	KP776016
<i>Impatiens chlorosepala</i>	KP776067	KP776017
<i>Impatiens clavigera</i>	KP776068	KP776018
<i>Impatiens conchibracteata</i>	AY348765	DQ147829

Species	ITS	<i>atpB-rbcL</i>
<i>Impatiens corchorifolia</i>	AY348767	DQ147831
<i>Impatiens cuspidata</i>	AY348769	DQ147832
<i>Impatiens cyanantha</i>	AY348770	DQ147833
<i>Impatiens cyathiflora</i>	AY348771	DQ147834
<i>Impatiens cymbifera</i>	KP776069	KP776019
<i>Impatiens davidii</i>	KP776070	KP776020
<i>Impatiens decurva</i>	MF979085	MF979082
<i>Impatiens delavayi</i>	AY348773	DQ147836
<i>Impatiens desmantha</i>	AY348774	DQ147837
<i>Impatiens drepanophora</i>	AY348776	DQ147838
<i>Impatiens duclouxii</i>	KP776071	KP776021
<i>Impatiens faberi</i>	AY348778	DQ147841
<i>Impatiens falcifer</i>	KP776072	KP776022
<i>Impatiens fischeri</i>	AY348781	DQ147843
<i>Impatiens fissicornis</i>	AY348782	DQ147844
<i>Impatiens flanaganae</i>	AY348783	DQ147846
<i>Impatiens florulenta</i>	MF979087	MF979084
<i>Impatiens forrestii</i>	AY348784	DQ147847
<i>Impatiens fragicolor</i>	KP776073	KP776023
<i>Impatiens gongshanensis</i>	KP776074	KP776024
<i>Impatiens harae</i>	KP776075	KP776025
<i>Impatiens hians</i>	AY348791	DQ147849
<i>Impatiens hongkongensis</i>	KP776076	KP776027
<i>Impatiens hunanensis</i>	KP776077	KP776028
<i>Impatiens imbecilla</i>	AY348796	DQ147851
<i>Impatiens inaperta</i>	AY348797	DQ147852
<i>Impatiens lateristachys</i>	KP776078	KP776030
<i>Impatiens laxiflora</i>	KP776079	KP776031
<i>Impatiens lecomtei</i>	AY348802	DQ147855
<i>Impatiens leptocaulon</i>	KP776080	KP776032
<i>Impatiens macrovexilla</i>	KP776082	KP776034
<i>Impatiens malipoensis</i>	KP776083	KP776035
<i>Impatiens margaritifera</i>	KP776084	KP776036
<i>Impatiens mengtzeana</i>	AY348806	DQ147858
<i>Impatiens meruensis</i>	AY348807	DQ147859
<i>Impatiens monticola</i>	AY348810	DQ147860
<i>Impatiens muscicola</i>	KC905500	KC905547
<i>Impatiens napoensis</i>	AY348811	DQ147861
<i>Impatiens neglecta</i>	KP776087	KP776038
<i>Impatiens noei</i>	KC905504	KC905548
<i>Impatiens noli-tangere</i>	KP776088	KP776039
<i>Impatiens nubigena</i>	KP776089	KP776040
<i>Impatiens nyimana</i>	KP776090	KP776041
<i>Impatiens oblongata</i>	MF979086	MF979083
<i>Impatiens omeiana</i>	KP776092	DQ147864
<i>Impatiens oxyanthera</i>	AY348814	DQ147865
<i>Impatiens parviflora</i>	AY348816	DQ147866
<i>Impatiens patula</i>	KC905509	KC905549
<i>Impatiens phuluangensis</i>	KC905517	KC905554
<i>Impatiens platychlaena</i>	AY348818	DQ147867
<i>Impatiens platypetala</i>	AY348819	DQ147868
<i>Impatiens poculifer</i>	AY348820	DQ147870

Species	ITS	<i>atpB-rbcL</i>
<i>Impatiens principis</i>	KP776096	KP776026
<i>Impatiens pritzelii</i>	AY348821	KP776045
<i>Impatiens pseudoviola</i>	AY348822	DQ147871
<i>Impatiens pterosepala</i>	KP776097	KP776046
<i>Impatiens purpurea</i>	AY348823	DQ147872
<i>Impatiens racemosa</i>	KP776098	DQ147873
<i>Impatiens radiata</i>	AY348824	KP776047
<i>Impatiens rectangula</i>	AY348825	DQ147874
<i>Impatiens rubrostriata</i>	AY348828	DQ147876
<i>Impatiens santisukii</i>	KC905528	KC905550
<i>Impatiens scabrida</i>	KP776099	DQ147877
<i>Impatiens scullyi</i>	KP776100	KP776048
<i>Impatiens scutisepala</i>	AY348830	DQ147878
<i>Impatiens siculifer</i>	KP776101	KP776049
<i>Impatiens sodenii</i>	AY348832	DQ147879
<i>Impatiens soulieana</i>	AY348833	DQ147880
<i>Impatiens spathulata</i>	KP776102	KP776050
<i>Impatiens stenosepala</i>	AY348835	DQ147881
<i>Impatiens sulcata</i>	KP776103	KP776051
<i>Impatiens sunkoshiensis</i>	KP776104	KP776052
<i>Impatiens taronensis</i>	AY348838	DQ147882
<i>Impatiens teitensis</i>	AY348840	DQ147883
<i>Impatiens tienmushanica</i>	KP776105	KP776053
<i>Impatiens tortisepala</i>	KP776106	KP776054
<i>Impatiens trichosepala</i>	AY348843	DQ147885
<i>Impatiens tuberculata</i>	KP776107	KP776055
<i>Impatiens tubulosa</i>	KP776108	KP776056
<i>Impatiens uliginosa</i>	AY348845	DQ147887
<i>Impatiens usambarensis</i>	AY348847	DQ147890
<i>Impatiens violiflora</i>	KC905541	KC905551
<i>Impatiens walleriana</i>	AY348849	DQ147892
<i>Impatiens wenshanensis</i>	KP776110	KP776057
<i>Impatiens wilsonii</i>	KP776111	KP776058
<i>Impatiens xanthina</i>	AY348850	DQ147893
<i>Impatiens yaoshanensis</i>	KP776112	KP776059

Appendix 2



Figure A1. Holotype of *Impatiens chenmoui* sp. nov.